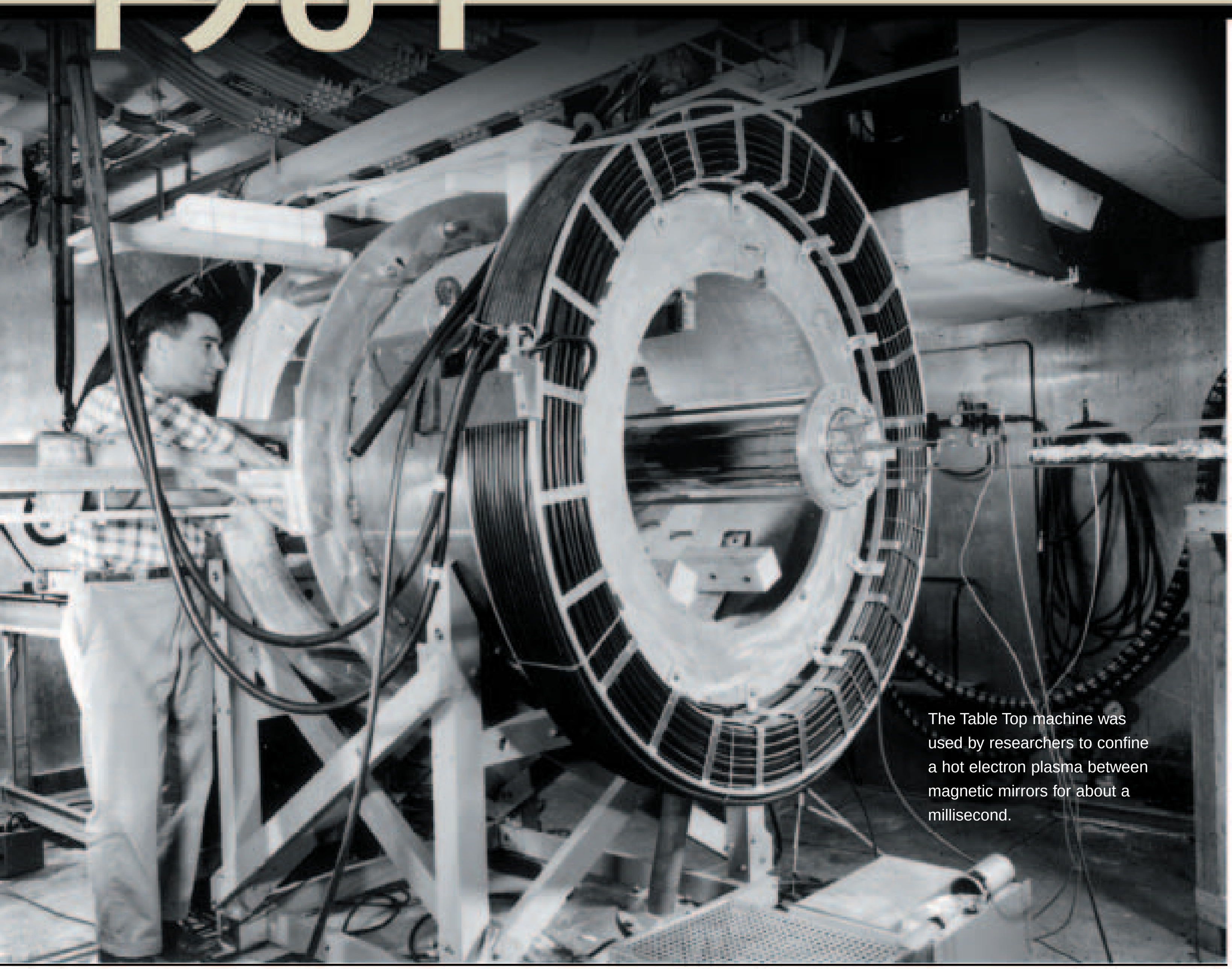
1961 Project Sherwood



The Table Top machine was used by researchers to confine a hot electron plasma between magnetic mirrors for about a millisecond.

Discovery of Element 114

Beginning in 1958, fusion researchers from the United States, Europe, the Soviet Union, and Japan shared their ideas and achievements—cooperation that persisted throughout the Cold War. Laboratory scientists now work collaboratively with Russian colleagues on a wide range of scientific projects. A notable example is the discovery of element 114. This long-sought experimental goal was achieved by researchers from Livermore and the Joint Institute for Nuclear Research in Dubna, Russia, in December 1998 (right). Element 114 lies in a predicted island of nuclear stability and lived for 30 seconds, which is 100,000 times longer than the previous new element found, element 112.

Magnetic Fusion and International Cooperation

In 1961, the International Atomic Energy Agency held its first conference on controlled nuclear fusion in Salzburg, Austria. It was the second international gathering of fusion researchers, following the 1958 Atoms for Peace Conference in Geneva, Switzerland. The Geneva conference had attracted 5,000 scientists, government officials, and observers, who witnessed the unveiling of fusion research by American, British, and Russian scientists. The weekend before the conference, the United States and Great Britain announced the end of secrecy in their controlled fusion research efforts. The Russians then announced that they had built the world's largest fusion research device, a doughnut-shaped machine called a tokamak, and declassified their research as well.

Livermore's Controlled Thermonuclear Reactions (CTR) Program, which was part of the Atomic Energy Commission's Project Sherwood, began when the Laboratory opened in 1952. Herbert York's original written prospectus for the Livermore site included the establishment of a small CTR group of about seven physicists and engineers. Richard Post, who wrote many of the CRT group's first monthly reports, was recruited by York to help launch the program. Early exploration of a number of concepts led the team to focus its efforts on the magnetic mirror concept, in which a hot fusion plasma (charged particles) would be confined in a cylindrical region by a uniform magnetic field with intensified fields at the ends. Researchers explored two experimental lines using two series of machines: one led by Post (Table Top, Felix, ALICE, and Baseball I and II) and the other led by Fred Coensgen (Toy Top, Toy Top II, 2X, 2XII, and 2XIIB).

At the 1958 Geneva conference, the Laboratory's significant achievements in magnetic fusion were reported: the creation of a hot, mirror-confined plasma in Toy Top; the confinement of a hot-electron plasma between mirrors for a millisecond using Table Top; successful measurement of plasma density; and the development of ultrahigh vacuum techniques for use in Felix. Laboratory researchers also formulated the idea of hydromagnetic instability of plasma confined in a simple mirror machine, developed the theory of adiabatic (i.e., slow) confinement of charged particles in mirror systems, and recognized the need to overcome impurity radiation losses from plasmas to achieve fusion temperatures.

After Geneva, fusion energy research hit roadblocks—plasma instabilities in Livermore's mirror machines allowed the hot plasma to escape. At the 1961 Salzburg conference, the Soviet Union's chief fusion experimentalist, L. A. Artsimovich, was sternly critical of Livermore's fusion research; however, the meeting did pave the way for future cooperation with Russian scientists while the Cold War raged. Artsimovich's colleagues shared how they suppressed plasma instabilities by reshaping the mirror field. Within months, Livermore researchers duplicated this result and went on to pioneer new and improved mirror field configurations (see Year 1977). However, overcoming other high-frequency plasma instabilities would prove to be a major obstacle.

An early fusion research device called Toy Top was used to create a hot, mirror-confined plasma by plasma injection and magnetic compression. Toy Top experiments succeeded in producing fusion neutrons, a significant early achievement in the controlled fusion program.